On Policy-based Extensible Management Approaches for Providing QoS

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Outline

- Management in the context of enterprise and telecom networks
- An introduction to policies
  - Work in the Research Community and IETF
- Policy as a means for programmable, extensible management systems
- Hierarchical Policies
- Policies in the context of the TEQUILA system for QoS management in the context of IP Diff-Serv
- Current state and future work

Enterprise Networks

- Typically single centralised “Network Management Centre”(NMC)
- NMC monitors the managed devices, only rudimentary management intelligence is typically supported
- Re-configuration is infrequent and driven by the human manager according to predefined “policy”
  - Central human-controlled configuration ensures no conflicts
- Ok for best-effort IP enterprise networks but not suitable for multiservice networks with increased management needs
  - The latter required frequent re-configuration for traffic engineering, driven from both network state and customer demands (SLSs etc.)

Telecommunication Networks

- Managed according to the hierarchical TMN model
- (Re-)Configuration of NEs takes place through Element Managers (EMs) driven by an overall configuration Network Manager (NM)
- NM applications implement network-wide policy through automated logic
- Configuration Manager holds the physical and logical network topology
- Requests from other applications are validated, conflicting configuration requirements are possible but should be avoided through rigorous testing
- Management intelligence is static, “hard-wired”: system is engineered according to requirements at time T_1 and cannot be easily modified / extended after that

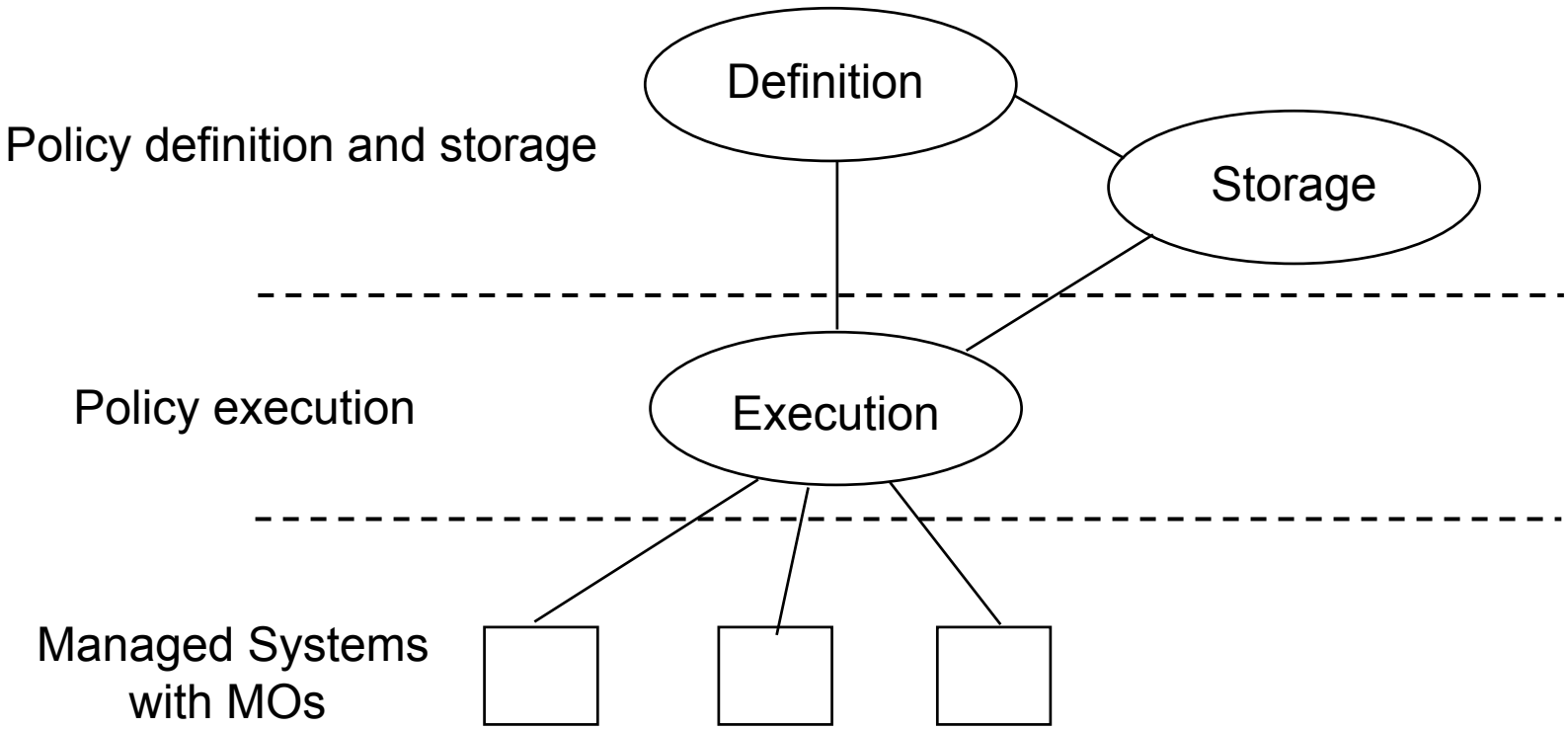
Policy-Based Management

- Management logic in Policy-based systems is expressed through declarative policies
- These are transformed in an interpreted fashion to low level actions to managed objects
- Key aspect: management intelligence can be modified, added and removed by manipulating policies
- Results in a highly dynamic system so conflicts are the norm rather than the exception
- Policies can be seen as a means to “late bind” functionality to an existing system
- Key aspect: where to draw the line between static, “hard-wired” management logic and flexible logic realised through policies

A Policy Conceptual Model

- A three-tier architecture
  - A policy definition and storage layer
    - Policies are first defined, checked for consistency, conflicts etc. and then stored
  - A policy execution layer where decisions are made and configuration actions are taken
    - Policies are the input from above and network information (events) the input from below
  - Policies manipulate managed objects in managed elements or in management applications
- A dynamic, fluid model compared to the conventional fixed, static models

A Policy Conceptual Model (cont'd)



Policies in the Research Community

- Distributed models
- Hybrid agent-manager applications with interpreted policy logic realising their management "intelligence"
- Policies: objects defining the relationships between subjects (managers) and targets (managed objects)
- Generic Classification of Policies
- Specification of Policy Notations and Languages
- Issues of policy refinement, conflict detection and resolution
- No convincing real-world applicability yet

Policies in IETF

- IETF sees policies as a means for service management in emerging QoS IP networks
  - "Intelligent" IP network, not just bit-pushing…
- Centralised Model
- Policy Consumers or Policy Decision Points (PDPs) enforce policies by manipulating MOs within Network Elements (NEs) or Policy Enforcement Points (PEPs)
- Policies are seen as the means for flexible service-driven network management
- Policy is defined as an aggregation of Policy Rules
  - Policy Rule: if <condition> then <action>
- Development of O-O information model for representing policies

Problems with IETF Policies

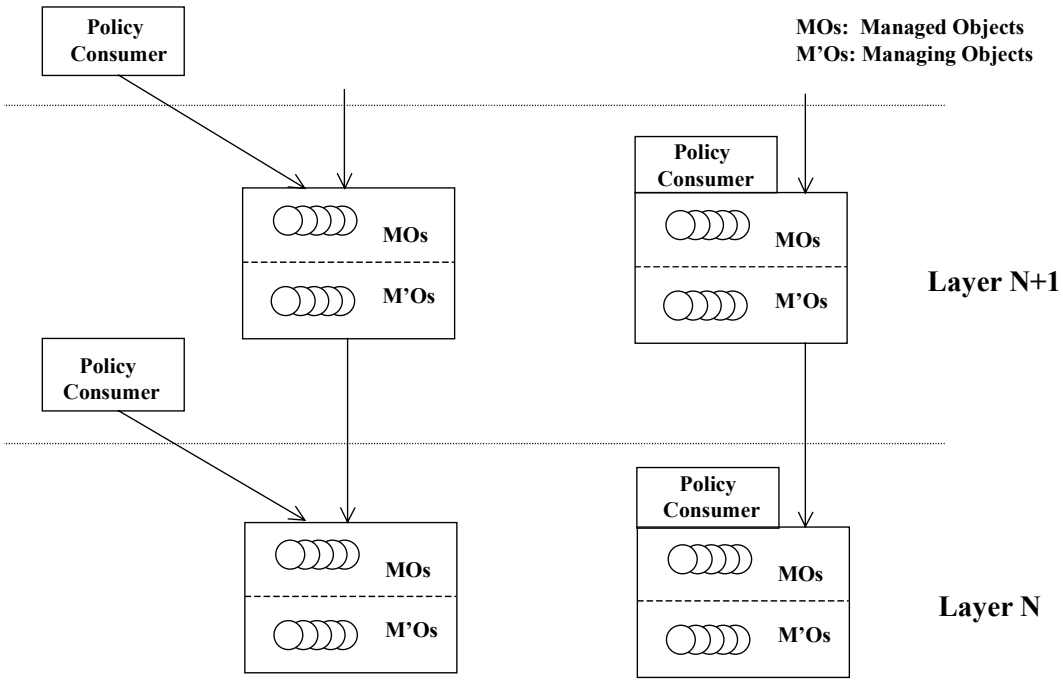
- Relatively low-level policies targeted mostly to consistent configuration across a number devices
- No policy language yet
- Policies cannot be triggered from network stimuli
  - Cannot support reactive fault and performance management functionality at least
- Centralised policy decision point for every different type of policy in a network e.g. QoS, security, etc.
  - Scalability?
  - Conflict detection and resolution? Possibly definition time but what about run-time conflicts
- Inter-domain policy?
- In summary, work to date has concentrated on protocols and interoperability given IETF's preoccupation
- Still a long way to go

Our View of Policies

- Try to bring together the IETF model, previous work in the research community + our ideas
- We see policies as a means for extensible systems that will have to co-exist with static, predefined management logic
  - Impossible to do *everything* with policies
- We feel the key advantage is the declarative high-level nature and potentially automated transformation
  - IETF focuses on relatively low-level procedural policies
- Since management systems are typically hierarchical, policies could mirror this hierarchy resulting in hierarchical policies when and where appropriate

Hierarchical Policies

- Policies may be considered as part of the managing intelligence of layer N+1 (left)
- Given their interpreted nature, they could execute at the agent-manager having local access to MOs (right)



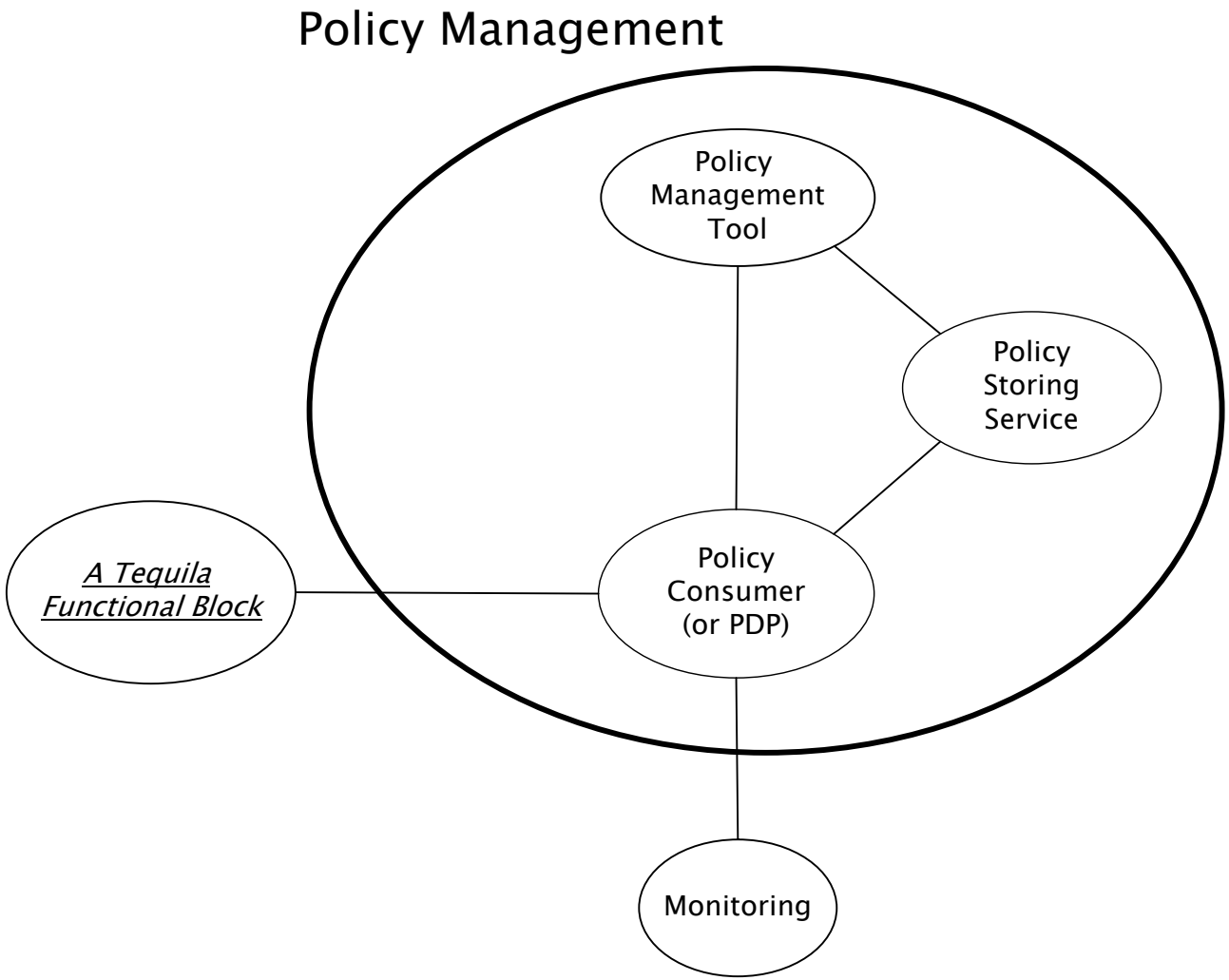
Policy Refinement

- Policy transformation and refinement
  - High-level Policies may result in the introduction of related policies at lower layers
  - Guidelines may be devised and followed in the context of a particular type hierarchical system that will assist and possibly automate the process of refinement
- We view policy refinement as a key issue for policy-based management
  - Otherwise, procedural low-level policies are no more than scripts that are checked for potential conflicts
- Very difficult problem in general but can be potentially solved in the context of a particular problem area
  - We hope to do something for dimensioning and resource management of Diff-Serv ☺

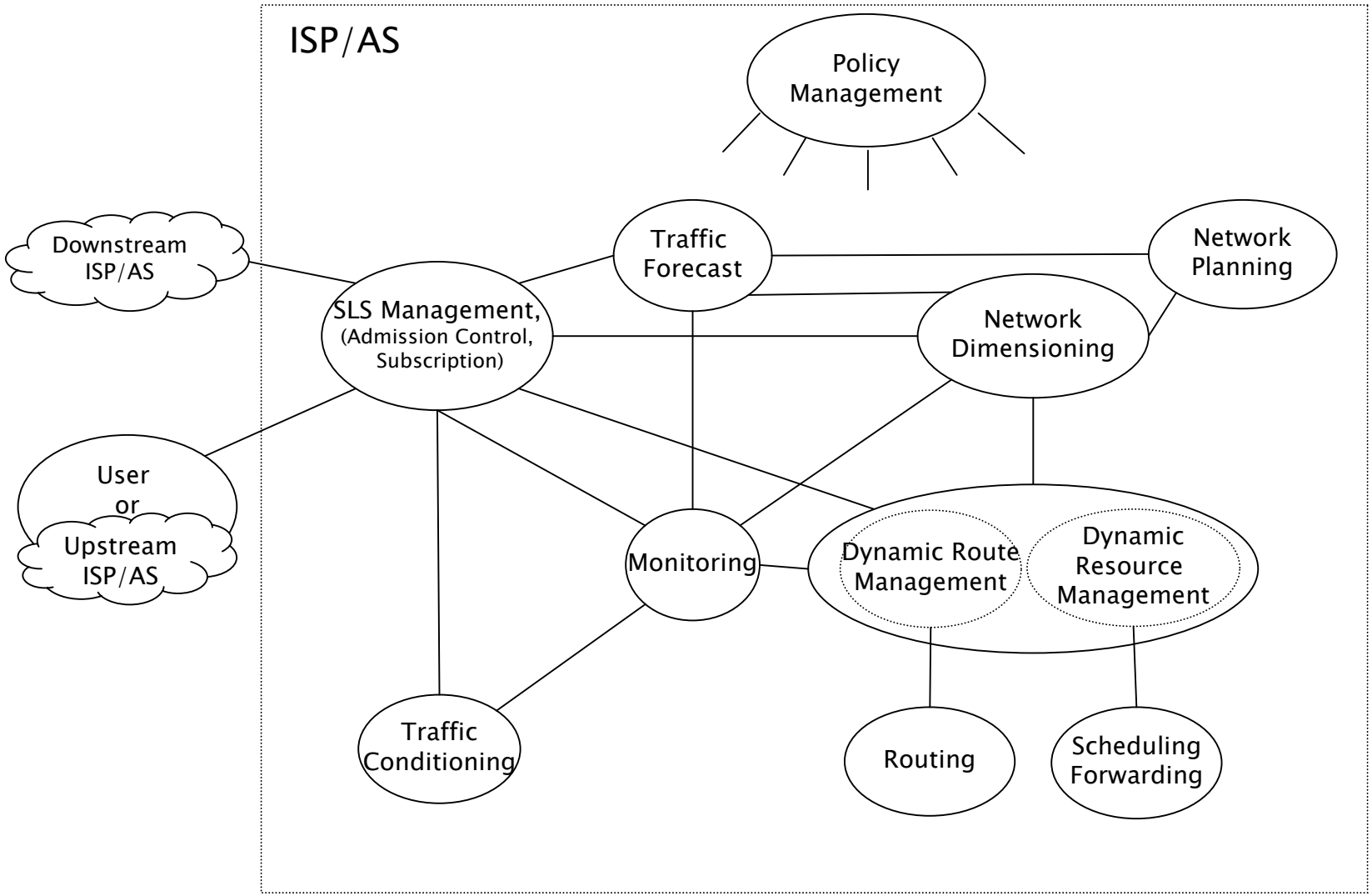
The TEQUILA Project

- The TEQUILA project (Traffic Engineering for QUality of service in the Internet at LArge scale) is used as the vehicle to explore policy aspects
- TEQUILA has designed an integrated management and control architecture to support end-to-end QoS in IP Diff-Serv networks
  - Planning & Dimensioning, SLS Management, Traffic Forecasting, Dynamic Route and Resource Management, Monitoring
- Policy management applies most components of the TEQUILA architecture
  - SLS Management policies, Dimensioning policies, Dynamic Route and Resource Management Policies
  - Dimensioning and Resource Management policies may have a hierarchical relationship
- Many policy consumers or PDPs with a single policy storing service (for static conflict detection) and a policy management tool for the network operator

Policy Management in TEQUILA



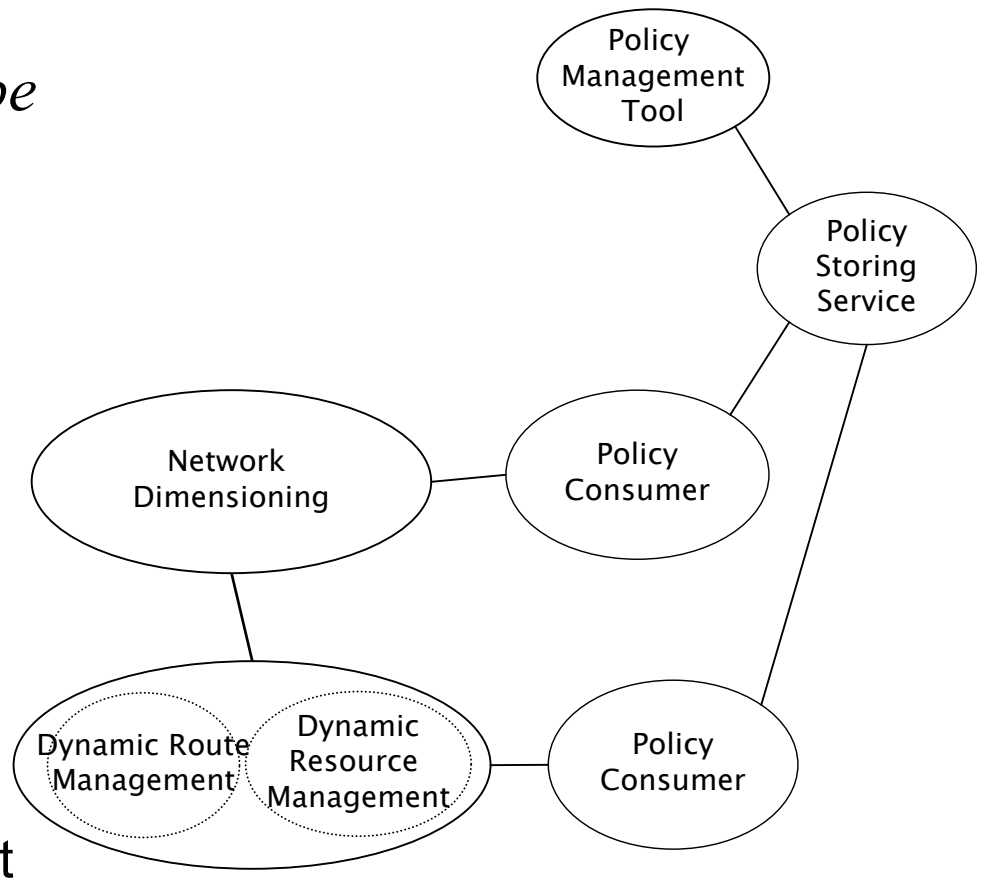
The TEQUILA functional architecture



An Example of Hierarchical Policy

- *"At least 10% of Network Resources should always be available for EF traffic"*
- Template of the generic policy class:

  <bound><percentage> *of Network Resources* ***<period>*** *available for* ***<traffic type>***
- Decomposed into:
  - a dimensioning policy
  - a dynamic resource mgmt policy



Summary and Future Work

- Description of the characteristics of policy-based management and its coexistence with static, hierarchical management systems
- Fundamental target is a management system able to sustain requirement changes and evolve gracefully through policies without changing its initial “hard-wired” logic
- Current and future work:
  - Definition of O-O Information model representing the capabilities of each layer of the TEQUILA achitecture
  - Specification of dimensioning and dynamic resource & route management policy classes
  - Explore the concept of decomposition and refinement